

TEONGRAV: an INFN initiative for the Theory of Gravitational Wave Sources

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National
Institute for
Nuclear
Physics

www.infn.it



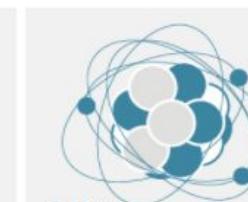
Istituto Nazionale di Fisica Nucleare



CSN1
Particle
physics



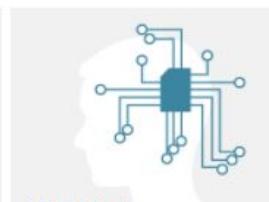
CSN2
Astroparticle
physics



CSN3
Nuclear
physics



CSN4
Theoretical
physics



CSN5
Technological
research

INFN Facilities

Within **Group IV**

(CSN4, <https://web.infn.it/CSN4/index.php/en>):

1. Field and String Theory
2. Phenomenology of Elementary Particles
3. Nuclear and Hadronic Physics
4. Mathematical Methods
- 5. Astroparticle Physics**
6. Statistical Physics and Applied Field Theory



Theory of Gravitational Wave Sources (TEoria delle sorgenti di ONde GRAVitazionali)

TEONGRAV is the largest Italian collaboration of theoretical physicists working on gravitational wave sources and compact objects. It mainly focuses its activities on these research topics:

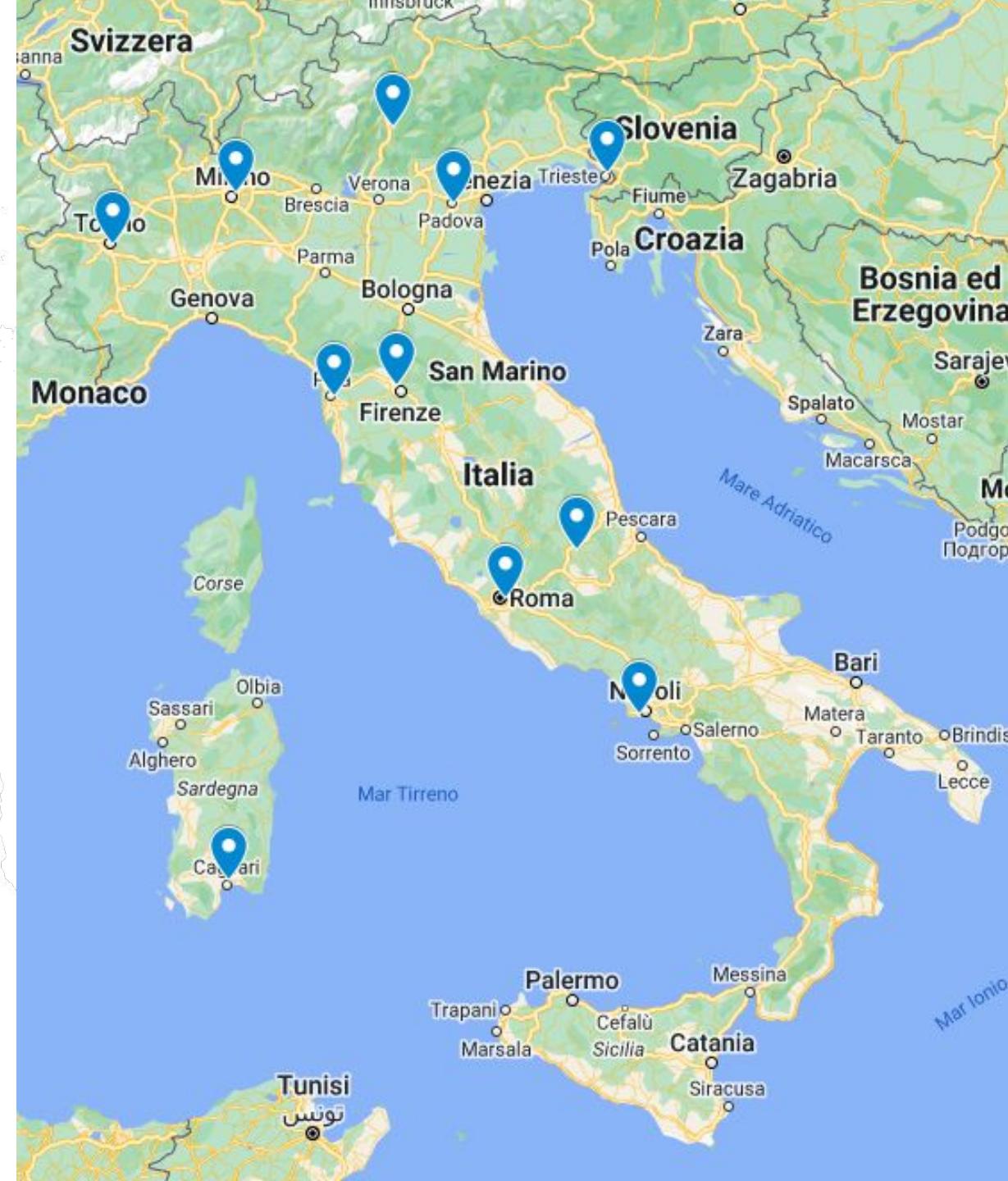
1. Modelling of gravitational wave sources via both analytic and numerical methods (Firenze, GSSI, Milano-Bicocca, Padova, Pisa, Roma, Trento, Torino, Trieste)
2. Use of theoretical models and observations to extract information on the equation of state of matter in the inner core of neutron stars (Firenze, GSSI, Milano-Bicocca, Padova, Pisa, Roma, Torino, Trento)
3. Study of the dynamics of black hole formation (Milano-Bicocca, Padova, Roma)
4. Study of electromagnetic counterparts of gravitational wave signals (Firenze, GSSI, Milano-Bicocca, Napoli, Padova, Trento)
5. Study of strong-field phenomena in modified gravity theories, in order to test general relativity and the nature of compact objects with gravitational waves and astrophysical observations (Cagliari, Firenze, GSSI, Milano-Bicocca, Napoli, Pisa, Roma, Torino, Trieste)

Theory of Gravitational Wave Sources (TEoria delle sorgenti di ONde GRAVitazionali)

Created in 1998 by Prof. Valeria Ferrari with 5 RUs

Now, 11 Research Units, 123 members, and growing...

- Cagliari (Leonardo Modesto)
- Firenze (Luca Del Zanna)
- L'Aquila-GSSI (Andrea Maselli)
- Milano-Bicocca (Bruno Giacomazzo)
- Napoli (Mariafelicia De Laurentis)
- Padova (Riccardo Ciolfi)
- Pisa (Leonardo Gualtieri)
- Roma (Paolo Pani)
- Torino (Alessandro Nagar)
- Trento (Albino Perego)
- Trieste-SISSA (Enrico Barausse)



Cagliari

1 faculty members:

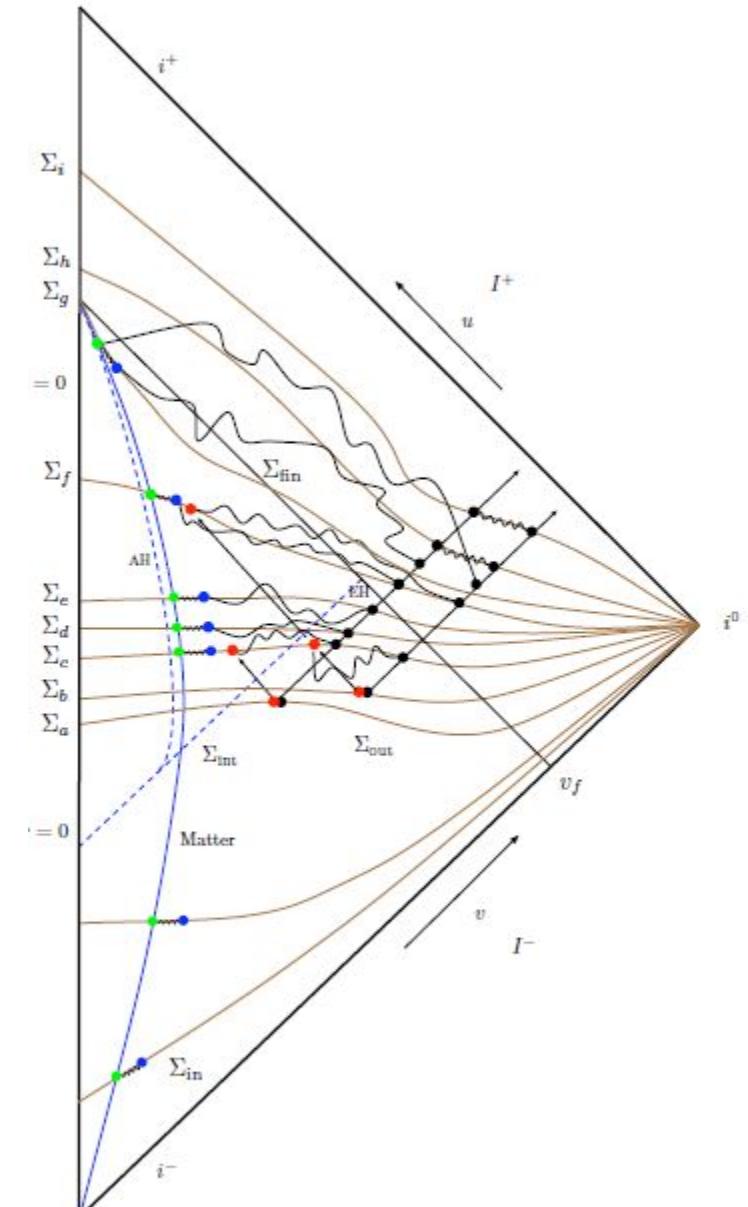
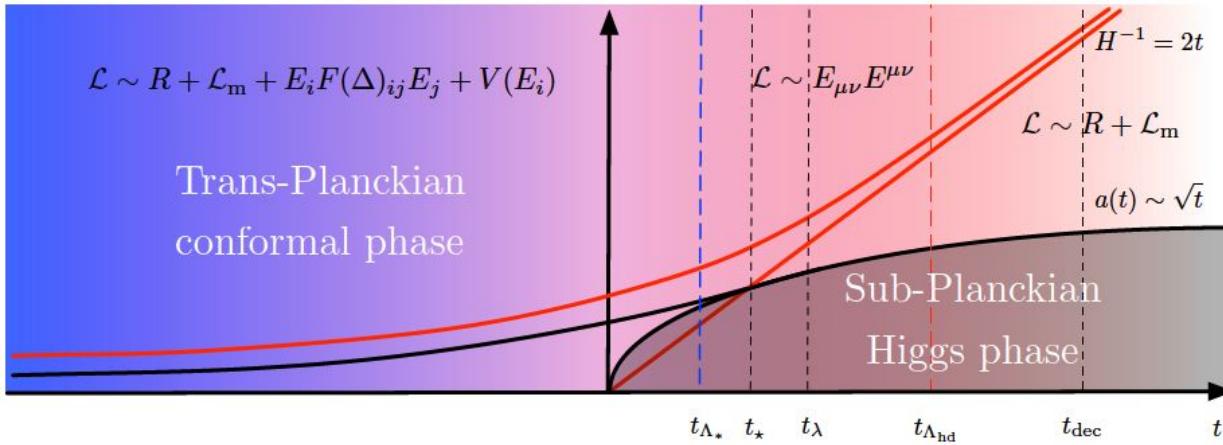
- Leonardo Modesto

2 PhD students (M. Pitzalis, L. Orlando)

Cagliari

Main Research Topics include:

- Test of theoretical predictions on the cosmological coupling of BHs
- Quantum gravity at the event horizon
- Primordial Gravitational Wave Background



Conformalons



Firenze



2 faculty members:

- Luca Del Zanna (UniFi)
- Niccolò Bucciantini (INAF-Arcetri)

1 postdoc:

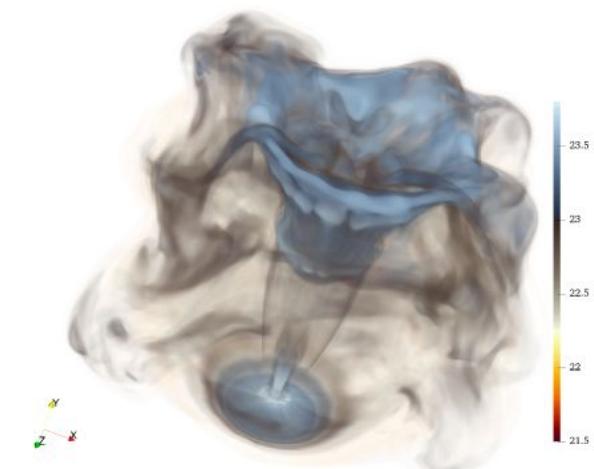
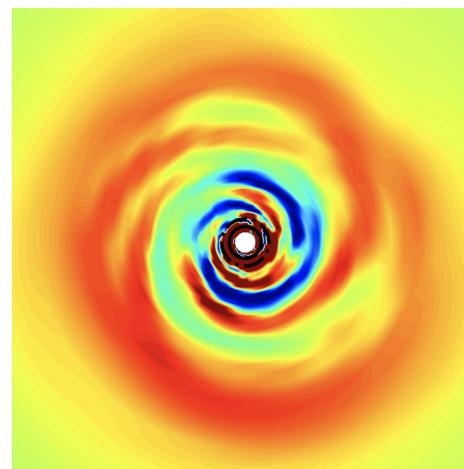
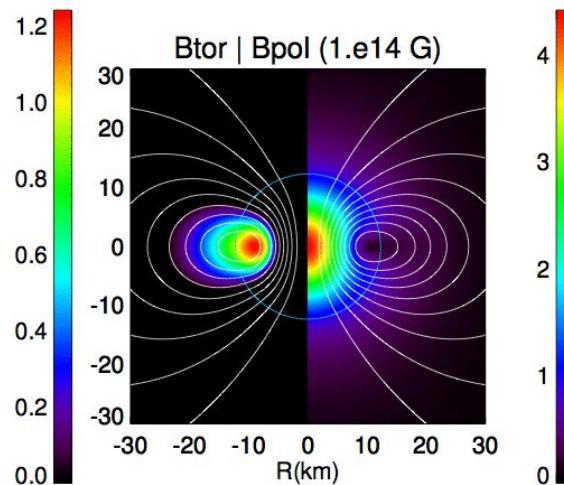
- Giancarlo Mattia (INFN)



Firenze

Main Research Topics include:

- GRMHD models of magnetized neutron stars (XNS code)
- dynamo processes in GRMHD accretion disks (ECHO code)
- resistive RMHD jets from BNS mergers (PLUTO code, with Padova)
- numerical methods for GRMHD (with Torino)



GSSI



3 faculty members:

- Manuel Arca Sedda, Andrea Maselli, Gor Oganessian

6 postdocs

- Stefano Ascenzi, Biswajit Banerjee, Sayak Datta, Riccardo Murgia, Marcelo Rubio, Filippo Santoliquido

9 PhD students

- Ansh Chopra, Andrea Cozzumbo, Sara Gliorio, Anjali Kugarajh, Annarita Ierardi, Samanta Macera, Alessio Mei, Laura Pezzella, Pawan Tiwari

GSSI

Main Research Topics include:

- Fundamental physics with gravitational wave observations
- Modelling of compact binaries as GW sources
- Waveform modelling for LISA sources
- GW data analysis
- Population studies of BH-BH, NS-BH, NS-NS mergers
- Modelling of EM counterparts of GW sources
- Cosmology of early Universe

Milano-Bicocca



8 faculty members:

- UniMiB: Colpi, Dotti, Gerosa, Giacomazzo, Sesana
- Insubria: Haardt, Lupi
- INAF: Salafia

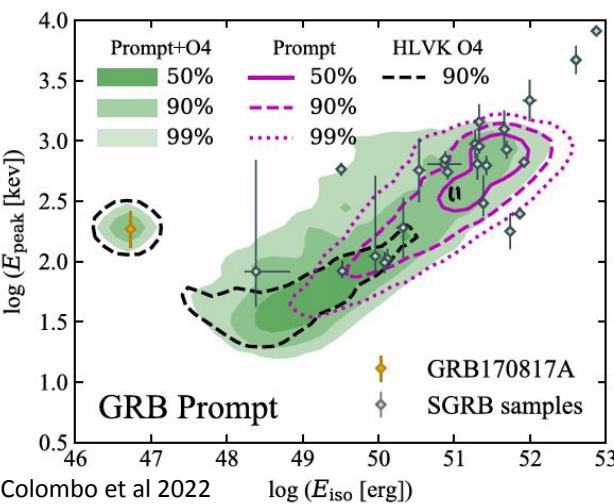
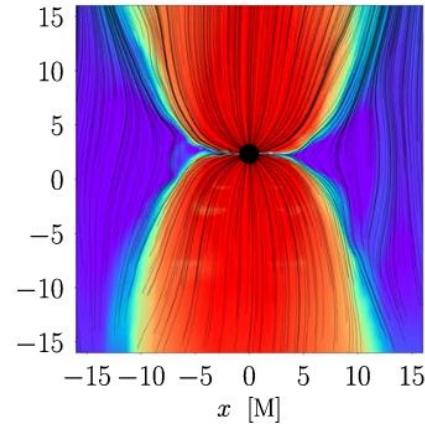
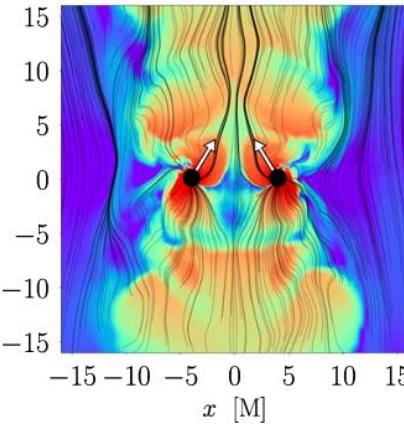
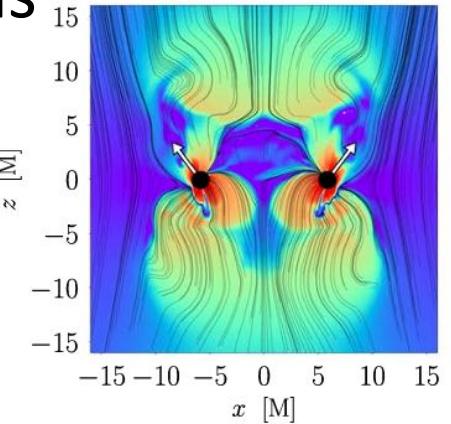
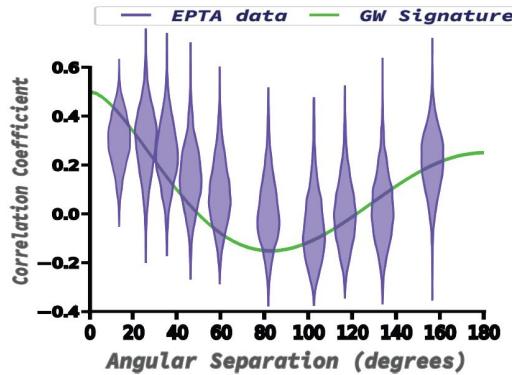
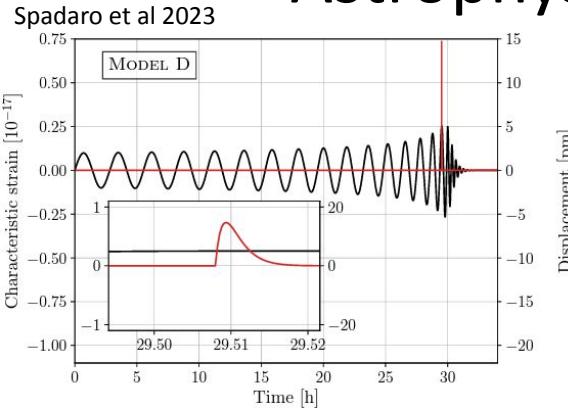
17 postdocs

11 PhD students

Milano-Bicocca

Main Research Topics include:

- Numerical relativity simulations
- GW data analysis (EPTA, LISA, Virgo sources)
- Population studies of BH-BH, NS-BH, NS-NS mergers
- Modelling of EM counterparts of GW sources
- N-body simulations of BH binary systems
- Newtonian and Relativistic simulations of BH accretion
- Cosmological simulations of massive BH mergers
- Semi-analytical models for LISA sources
- Astrophysical GW backgrounds



Napoli



3 faculty members:

- Mariafelicia De Laurentis, Maurizio Paolillo, Daniele Vernieri (UNINA)

1 postdocs:

- Vittorio De Falco

2 PhD students (starting now)

- Pietro Farina, Alessandro Tiano

Napoli

Main Research Topics include:

Tests of Theories of Gravity

Dynamics of stars around SMBH

Study of magnetic disks and photon rings around SMBH

Relativistic three-body problem

Padova



UNIVERSITÀ
DEGLI STUDI
DI PADOVA



3 faculty members:

- INAF: Riccardo Ciolfi (coordinator)
- UniPD: Michela Mapelli, Giuliano Iorio (leaving soon)

4 postdocs: Marco Dall'Amico, Elena Lacchin, Andrea Pavan,
Matteo Pais

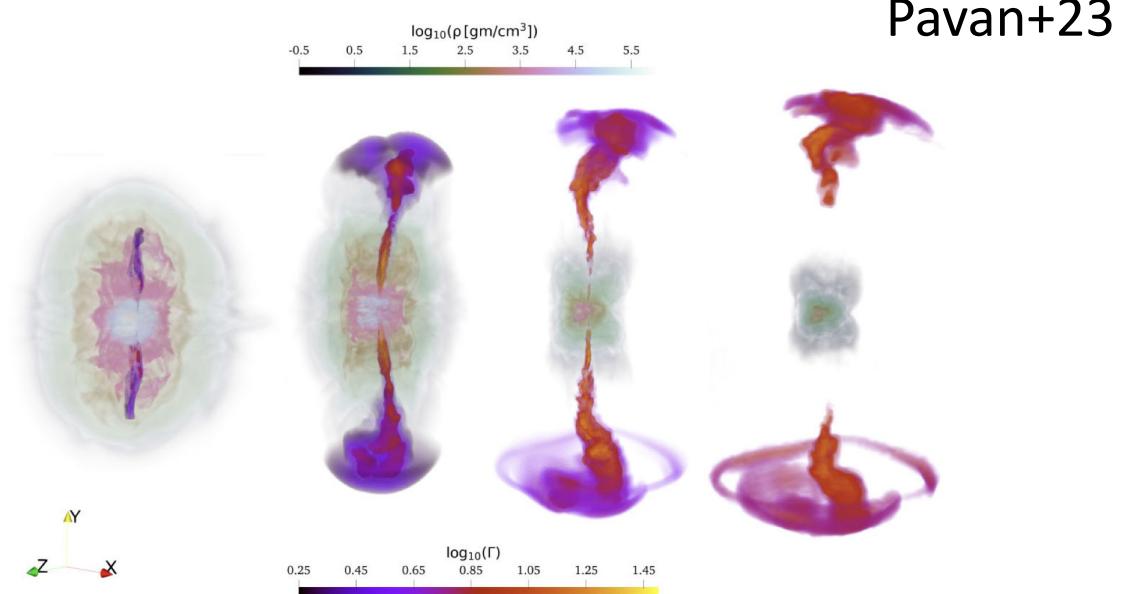
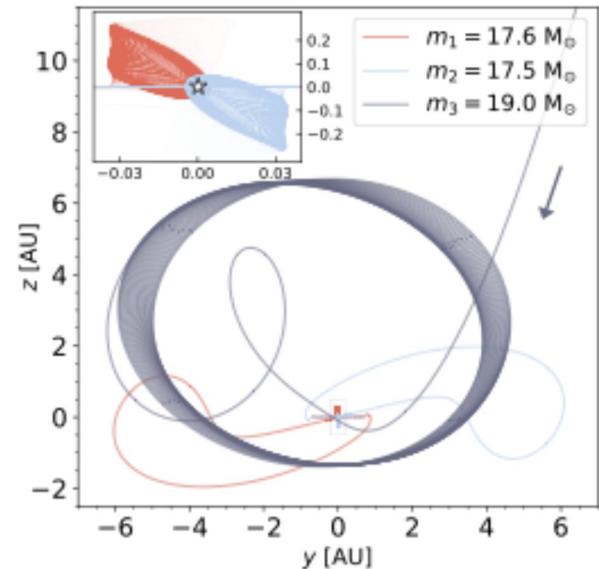
1 PhD student: Erika Korb

Padova

Main Research Topics include:

- Population studies of binary compact objects in isolated and dynamical environment
- Black holes formation in dynamical active environments (stellar clusters) through N-body simulations and semi-analytic codes
- Study of the population of compact objects in the Milky Way
- General relativistic MHD simulations of binary neutron star mergers
- Relativistic MHD simulations of gamma-ray burst jets

Dall'Amico+23



Pisa

- 3 faculty members:

- Leonardo Gualtieri, Walter Del Pozzo, Angelo Ricciardone



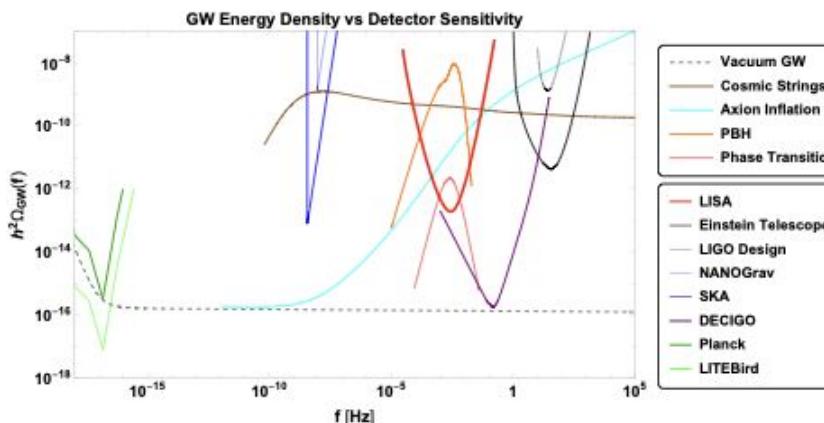
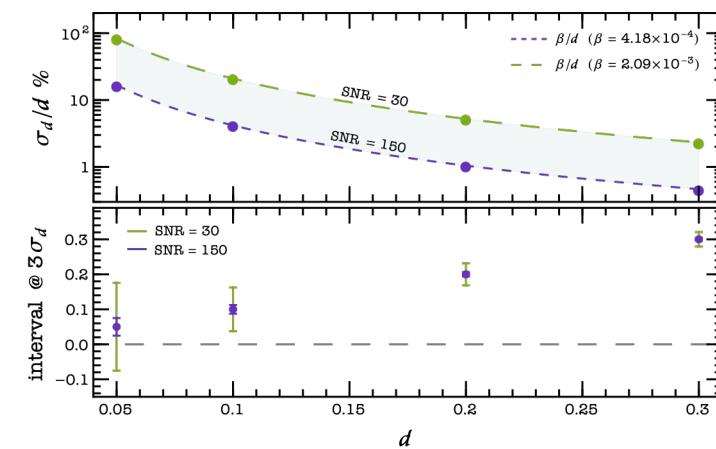
- 3 PhD students:

- Matteo Della Rocca, Ilaria Caporali, Dario Rossi (will start next month)

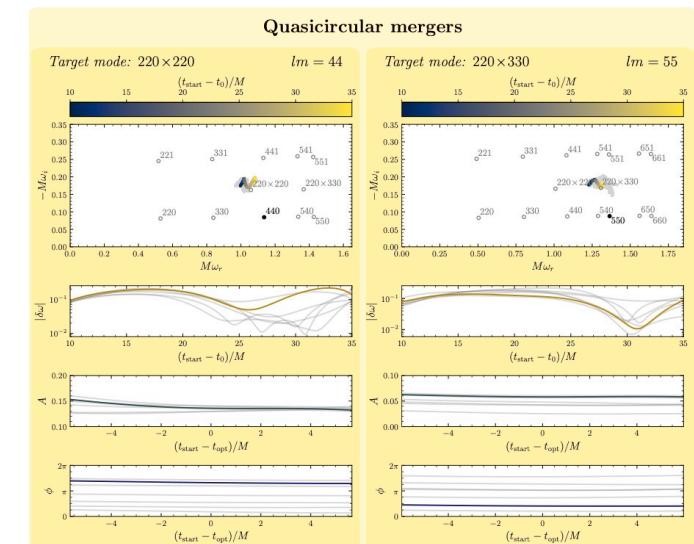


Some of the research lines of TENOGRAV-Pisa:

- Modelling of black hole binaries and of the emitted GW signals beyond GR
 - comparable mass binaries: inspiral, merger, ringdown
 - extreme mass-ratio inspirals
- Gravitational wave sources as probes of dark matter
- Modelling of the GW stochastic backgrounds (astrophysical and cosmological)
- Data analysis techniques to extract signatures of new physics from resolved and stochastic GW signals (inspiral, ringdown)
- Binary neutron stars as probes of the neutron star equation of state
- Inference of astrophysical and cosmological models parameters



LRR 2023
(LISA Cosmology WG)



Roma



7 faculty members:

- Luca Graziani, Paolo Pani, Francesco Pannarale, Fabio Riccioni (INFN), Raffaella Schneider, Alfredo Urbano, Rosa Valiante (INAF), Tommaso Zana

9 postdocs:

- Antoniou G. (INFN), Corelli F., Croft R., Destounis K., Dima A., Franzin E., Gambino C., Giovannetti E., Musco I.,

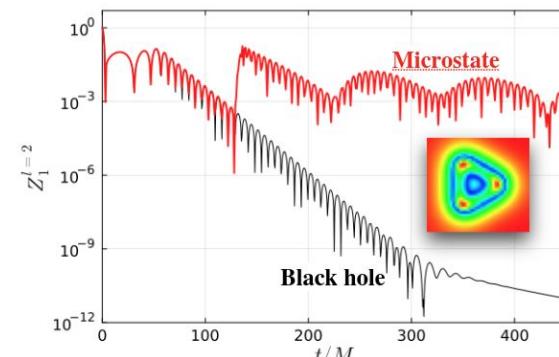
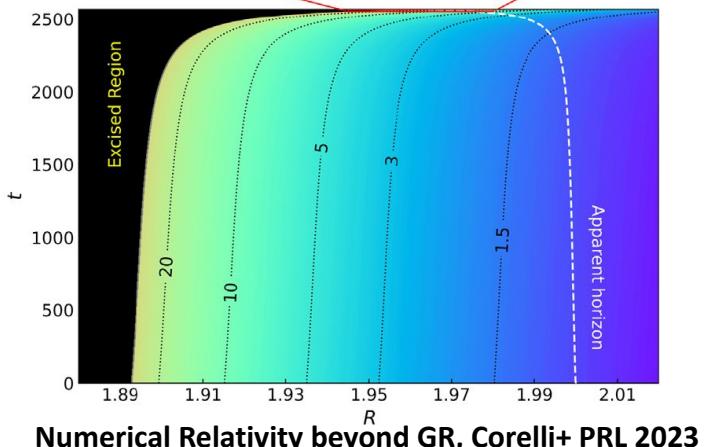
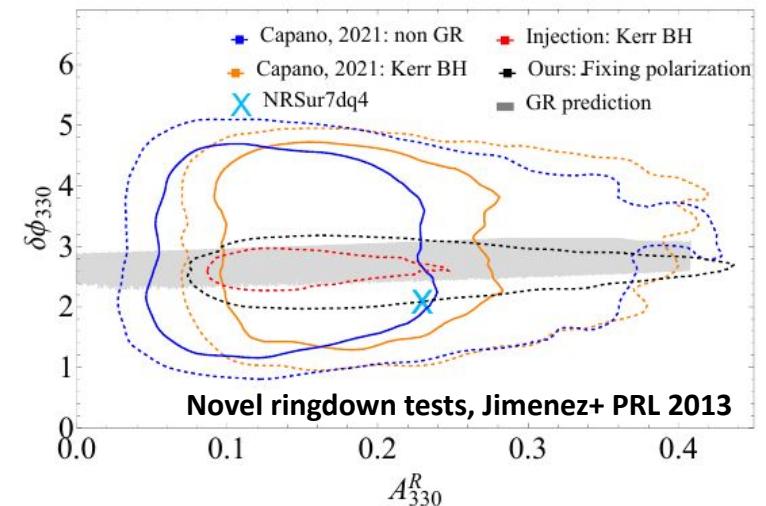
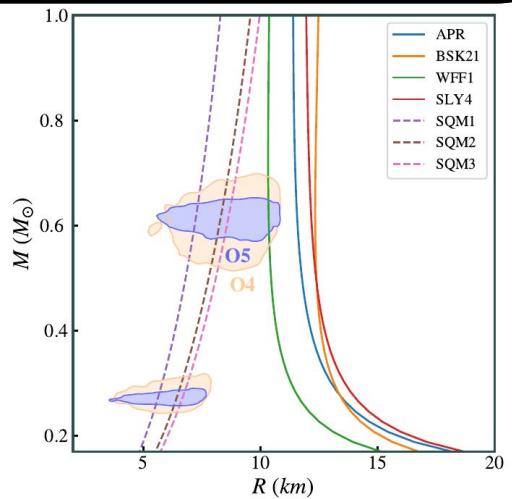
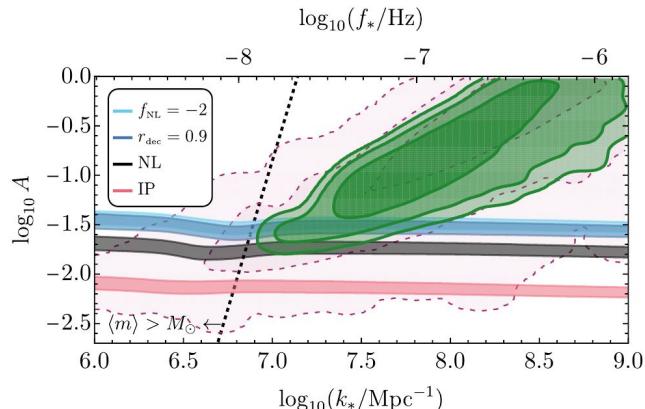
6+2 PhD students:

- Angeloni F., Bruno M., Crescimbeni F., Del Grosso L, Iovino A., Melis M., Rosato R.F. (starting this year), Zhao Y. (starting this year)

Roma

Main Research Topics include:

1. GW modelling and phenomenology
2. Tests of gravity and compact objects
3. Gravity & astroparticle physics
4. Gravity & HEP
5. Formation and evolution of first galaxies, stars, and black holes



Torino

1 faculty members

Alessandro Nagar (INFN)

2 postdoc

Jake Lange (INFN, starting October 2019)

Matteo Bugli (Unito)

1 PhD student

Danilo Chiaramello

People strongly connected with the group (though formally not part of it):

Andrea Placidi (post-doc, UniPg)

Piero Rettegno (post-doc, UniPg)

Simone Albanesi (post-doc, UniJena)

Rossella Gamba (post-doc, Berkeley)

Torino

Main Research Topics include:

- Gravitational waveform modeling from coalescing compact binaries
- Analytical relativity (PN,PM,EOB)
- Numerical Relativity (AthenaGR++ development)
- LVK/ET binaries (BBHs, BNS) and LISA sources (EMRIs)
- Core collapse supernova simulation
- Theoretical support activity to waveform modeling in LVK

Trento

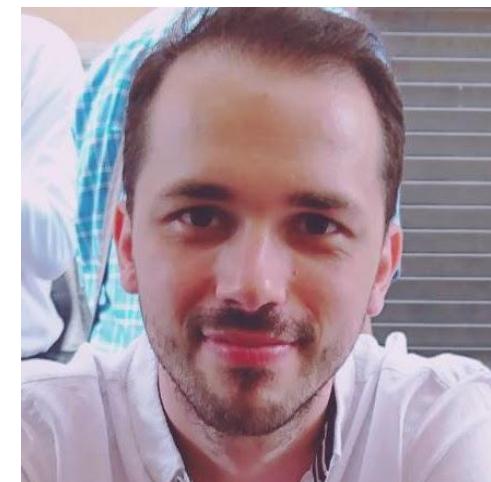
1 faculty members:

- Albino Perego



1 postdoc

- Federico Guercilena



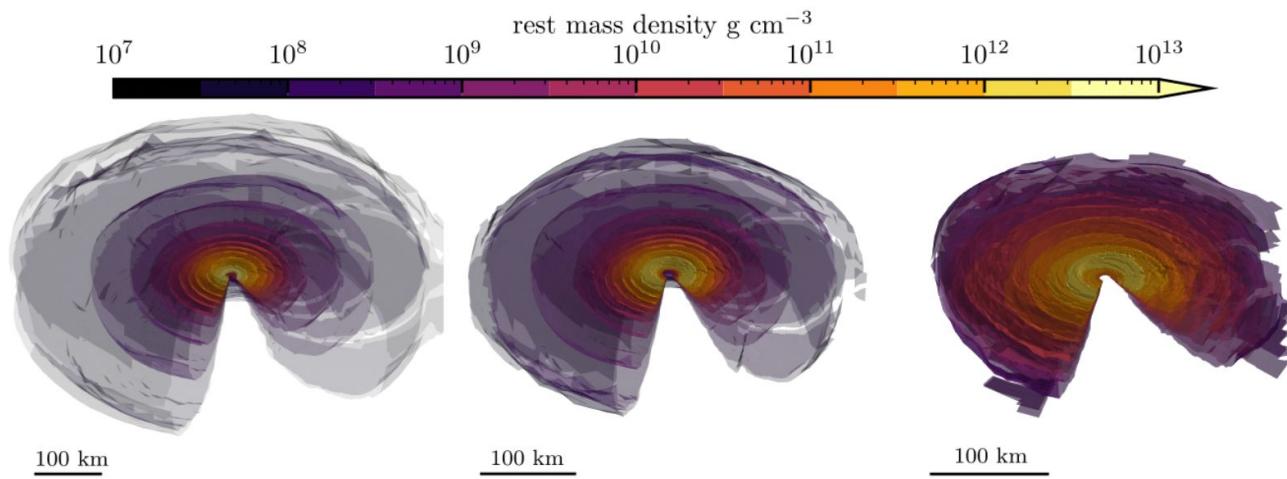
2 PhD students

- Alessandro Camilletti
- Leonardo Chiesa

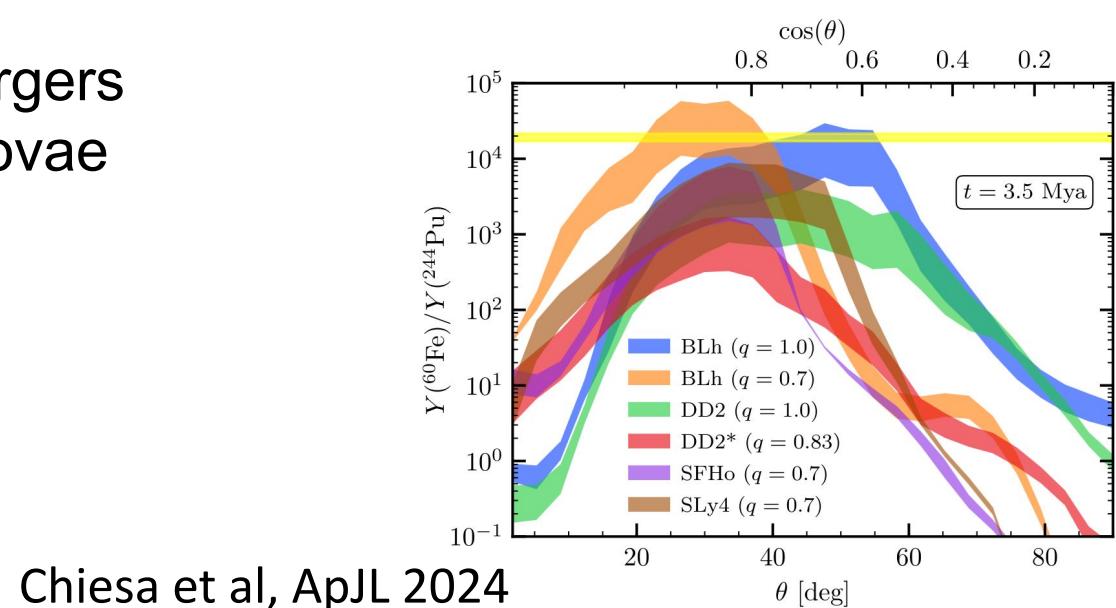
Trento

Main Research Topics include:

- BNS merger simulations in Numerical Relativity
- EOS for neutron star modeling & astrophysical simulations
- neutrinos & weak interactions in mergers
- modelling of EM counterparts: kilonovae
- nucleosynthesis in merger



Camilletti et al, PRD 2024



Trieste

2 faculty members: Enrico Barausse, Mario Spera

7 postdocs (+2 starting next month): U Di Carlo, J Sadiq, A Kuntz, R Srinivasan, M Vaglio, R Cayuso, R Chadramouli, A Frassino, C Pitte

4 PhD students: L Capuano, L Copparoni, C Sgalletta, E Dreas



Trieste

Main Research Topics include:

- Tests of General Relativity
- Waveform modeling and data analysis
- Population models for LVK, LISA, PTAs

(some of) TEONGRAV Collaborations

- LIGO-Virgo-KAGRA Collaboration
- Einstein Telescope Collaboration
- LISA Consortium
- European/International Pulsar Timing Array (EPTA/IPTA)
- Event Horizon Telescope
- ENGRAVE
- THESEUS
- GRAWITA
- Einstein Toolkit

<https://web.infn.it/CSN4/index.php/it/17-esperimenti/195-teongrav-home>